TITLE

MULTI-PART PLUNGER

CROSS REFERENCE APPLICATIONS

This application is a non-provisional application claiming the benefits of provisional application no. 60/456,667 filed March 18, 2003.

FIELD OF THE INVENTION

The present invention relates to an improved plunger lift apparatus for the lifting of formation liquids in a hydrocarbon well. More specifically the improved plunger consists of a two piece apparatus that operates to increase the well efficiency, insure positive mechanical connection during lift, and separate at the top of the well.

BACKGROUND OF THE INVENTION

A plunger lift is an apparatus that is used to increase the productivity of oil and gas wells. In the early stages of a well's life, liquid loading is usually not a problem. When rates are high, the well liquids are carried out of the tubing by the high velocity gas. As the well declines, a critical velocity is reached below which the heavier liquids

do not make it to the surface and start to fall back to the bottom exerting back pressure on the formation, thus loading up the well. A plunger system is a method of unloading gas in high ratio oil wells without interrupting production. In operation, the plunger travels to the bottom of the well where the loading fluid is picked up by the plunger and is brought to the surface removing all liquids in the tubing. The plunger also keeps the tubing free of paraffin, salt or scale build-up. A plunger lift system works by cycling a well open and closed. During the open time a plunger interfaces between a liquid slug and gas. The gas below the plunger will push the plunger and liquid to the surface. This removal of the liquid from the tubing bore allows an additional volume of gas to flow from a producing well. A plunger lift requires sufficient gas presence within the well to be functional in driving the system. Oil wells making no gas are thus not plunger lift candidates.

As the flow rate and pressures decline in a well, lifting efficiency declines geometrically. Before long the well begins to "load up". This is a condition whereby the gas being produced by the formation can no longer carry the liquid being produced to the surface. There are two reasons this occurs. First, as liquid comes in contact with the wall of the production string of tubing, friction occurs. The

velocity of the liquid is slowed and some of the liquid adheres to the tubing wall, creating a film of liquid on the tubing wall. This liquid does not reach the surface. Secondly, as the flow velocity continues to slow the gas phase can no longer support liquid in either slug form or droplet form. This liquid along with the liquid film on the sides of the tubing begin to fall back to the bottom of the well. In a very aggravated situation there will be liquid in the bottom of the well with only a small amount of gas being produced at the surface. The produced gas must bubble through the liquid at the bottom of the well and then flow to the surface. Because of the low velocity very little liquid, if any, is carried to the surface by the gas. Thus, as explained previously, a plunger lift will act to remove the accumulated liquid.

A typical installation plunger lift system **100** can be seen in Fig. 1. Lubricator assembly **10** is one of the most important components of plunger system **100**. Lubricator assembly **10** includes cap **1**, integral top bumper spring **2**, striking pad **3**, and extracting rod **4**. Extracting rod **4** may or may not be employed depending on the plunger type. Below lubricator **10** is plunger auto catching device **5** and plunger sensing device **6**. Sensing device **6** sends a signal to surface controller **15** upon united plunger mechanism (UPM) **200** arrival at the well top. UPM **200** is shown to represent the

plunger of the present invention and will be described below in more detail. Sensing the plunger is used as a programming input to achieve the desired well production, flow times and wellhead operating pressures. Master valve **7** should be sized correctly for the tubing **9** and UPM **200**. An incorrectly sized master valve will not allow UPM **200** to pass. Master valve **7** should incorporate a full bore opening equal to the tubing **9** size. An oversized valve will allow gas to bypass the plunger causing it to stall in the valve. If the plunger is to be used in a well with relatively high formation pressures, care must be taken to balance tubing **9** size with the casing **8** size. The bottom of a well is typically equipped with a seating nipple/tubing stop **12**. Spring standing valve/bottom hole bumper assembly **11** is located near the tubing bottom. The bumper spring is located above the standing valve and can be manufactured as an integral part of the standing valve or as a separate component of the plunger system.

Surface control equipment usually consists of motor valve(s) **14**, sensors **6**, pressure recorders **16**, etc., and an electronic controller **15** which opens and closes the well at the surface. Well flow '**F**' proceeds downstream when surface controller **15** opens well head flow valves. Controllers operate on time, or pressure, to open or close the surface

valves based on operator-determined requirements for production. Modern electronic controllers incorporate features that are user friendly, easy to program, addressing the shortcomings of mechanical controllers and early electronic controllers. Additional features include: battery life extension through solar panel recharging, computer memory program retention in the event of battery failure and built-in lightning protection. For complex operating conditions, controllers can be purchased that have multiple valve capability to fully automate the production process.

Modern plungers are designed with various sidewall geometries and can be generally described as follows:

A. Shifting ring plungers for continuous contact against the tubing to produce an effective seal with wiping action to ensure that all scale, salt or paraffin is removed from the tubing wall. Some designs have by-pass valves to permit fluid to flow through during the return trip to the bumper spring with the by-pass shutting when the plunger reaches the bottom. The by-pass feature optimizes plunger travel time in high liquid wells

B. Pad plungers with spring-loaded interlocking pads in one or more sections. The pads expand and contract to compensate for any irregularities in the tubing thus creating a tight friction seal. Pad plungers can also have a by-pass valve as described above.

C. Brush plungers incorporate a spiral-wound, flexible nylon brush section to create a seal and allow the plunger to travel despite the presence of sand, coal fines, tubing irregularities, etc. By-pass valves may also be incorporated.

D. Solid plungers with solid sidewall rings for durability. Solid sidewall rings can be made of various materials such as steel, poly materials, Teflon, stainless steel, etc. Once again, by-pass valves can be incorporated.

E. Snake plungers, which are flexible for coiled tubing and directional holes, and can be used as well in straight standard tubing.

Recent practices toward slim-hole wells that utilize coiled tubing lend also themselves to plunger systems.

Because of the small tubing diameters, a relatively small amount of liquid may cause a well to load-up or a relatively small amount of paraffin may plug the tubing.

Plungers use the volume of gas stored in the casing and the formation during the shut-in time to push the liquid load and plunger to surface when the motor valve opens the well to the sales line or to the atmosphere. To operate a plunger installation, only the pressure and gas volume in the tubing/casing annulus is usually considered as the source of energy for bringing the liquid load and plunger to surface.

The major forces acting on the cross-sectional area of the bottom of the plunger are:

- The pressure of the gas in the casing pushes up on the liquid load and the plunger;
- The sales line operating pressure and atmospheric pressure push down on the plunger
- The weight of the liquid and the plunger pushes down on the plunger;

- Once the plunger begins moving to the surface, friction between the tubing and the liquid load acts to oppose the plunger;
- In addition, friction between the gas and tubing acts to slow the expansion of the gas.

The major disadvantage of conventional plunger lifts is that the well must be shut-in in order for the plunger to fall to the bottom of the well. Two part plunger systems (ball-type or other non-positive mechanical plungers) can lose plunger piece to piece contact during lift due a drop in critical velocity, collar banging, hitting slugs of fluid, paraffin or scale particles, which decreases well efficiency. If the ball falls back to the bottom, fluid is then allowed to fall back to the bottom, which keeps the well in a loaded state. The only thing that holds the ball on the plunger is the upward flow of gas and fluid. <u>See U.S. Patent Nos. 6,209,637 and 6,467,544 to Wells. When the Wells two-part piston rises, changing well conditions can cause the ball to disconnect from the sleeve, resulting in lost well production.</u>

<u>The present invention in its various embodiments latches a lower plug to an upper sleeve, thereby preventing an accidental separation.</u> Plunger drop travel time slows or

limits well production. Also fishing balls out of a well is a problem and sometimes requires pulling the complete tubing string. Well production increases are always critical. What is needed is a plunger lift apparatus that can insure a positive contact during lift, drop back to the well bottom quickly and easily and assist in increasing well production by increasing lift cycle times. What is also needed is a two-part plunger system that is retrievable from the well. The apparatus of the present invention provides a solution to these aforementioned deficiencies.

SUMMARY OF THE INVENTION

The main aspect of the present invention is to provide a two part plunger apparatus that will increase well production levels.

Another aspect of the present invention is to provide a two part plunger apparatus that ensures a mechanical connection during the lift from the well bottom and that will mechanically separate at the lift top.

Another aspect of the present invention is to allow both the plunger top mechanism (PTM) and the plunger bottom mechanism (PBM) to independently fall inside the tubing to the well hole bottom with increased speed without impeding well production.

Another aspect of the present invention is to allow for current plunger sidewall geometries to be utilized in the PTM.

Yet another aspect of the present invention is to provide for a magnetic latching of the PTM and PBM during lift, the preferred embodiment.

Another aspect of the present invention is to provide for a mechanical latching of the PTM and PBM during lift, an alternate embodiment.

Yet another aspect of the present design is to provide a design that has an inherent flow by-pass when falling, thus eliminating any need for a by-pass valve.

Other aspects of this invention will appear from the following description and appended claims, reference being made to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

The present invention comprises a plunger lift consisting of two separate parts that will latch together at the well bottom thus creating a united plunger mechanism (UPM) acting to carry fluids from the bottom of the well to the surface. The latching is a magnetic latching in the preferred embodiment. The latching can also be a mechanical latching in alternate embodiments. The UPM latching is deactivated at the top of the well by a rod or other de-latching device, thereby separating the UPM into the PTM and PBM. The PTM is auto-caught and held in the lubricator at the top surface while the PBM is allowed to separately fall back into the well.

The PTM will be dropped back into the well when well conditions are met with liquid loading. The PTM will re-latch to the PBM when it returns to the well bottom to form a solid two-piece plunger, the UPM.

The preferred embodiment of the present invention employs a fairly strong permanent magnet, which is encased within the PBM to provide a magnetic attachment to the PTM. Other embodiments of the present invention employ a mechanical latch between the PTM and PBM during lift.

The PBM is designed to have a small outside diameter (OD) than the tubing and a geometric design to allow it to

quickly travel to the well bottom without impeding well flow. The PTM is designed with standard aforementioned sidewall geometries and a hollow inside to allow it to quickly travel to the well bottom once it is released by the auto-catcher at the surface.

The present invention assures an efficient lift due to the fact that both the PTM and PBM are latched to form one plunger unit during lift. The present invention also optimizes well efficiency due to the fact that both PTM and PBM can separately and quickly travel to the well bottom.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 (prior art) is an overview depiction of a typical plunger lift system installation.

Fig. 2 is a side view of the preferred embodiment of a UPM, separated into its PTM and PBM units.

Fig. 2A is a cross-sectional view of the PBM unit at point A-A of Fig. 2.

Fig. 3 is a side cross sectional view of the preferred embodiment of the present invention showing the UPM, shown in its magnetically latched state.

Figs. 4A, 4B is a blow-up cross-sectional view of the preferred embodiment of the present invention showing each subassembly of the UPM.

Fig. 5 is a side view of the PTM.

Fig. 6 is a side view of various side-wall geometries of the PTM.

Fig. 7 is a side view of the UPM with magnetic latching, the preferred embodiment of the present invention.

Fig. 8 is a side view of latch-down pickup, an alternate embodiment of the present invention.

Fig. 8A is a blow up of the latch-down pickup area of a compression ring pickup shown in Fig. 8.

Fig. 9 is a side view of a compression ring pickup, yet another alternate embodiment of the present invention.

Fig. 9A is a blow up of the compression ring pickup area as shown in Fig. 9.

Fig. 10 is a side view of a spring-loaded pickup, still another alternate embodiment of the present invention.

Fig. 10A is a blow up of the spring-loaded pickup area as shown in Fig. 10.

Fig. 11 is a horizontal cross-sectional view of Fig. 2, taken along line A-A, viewed in the direction taken by the arrows.

Fig. 12 is a horizontal cross-sectional view of Fig. 5, taken along line B-B, viewed in the direction taken by the arrows.

Fig. 13 is a side view of a spring-loaded top sleeve having a ball as the sealing plunger.

Fig. 14 is a side view of a compression ring top sleeve having a ball as the sealing plunger.

Fig. 15 is a side view of a latch down top sleeve having a ball as the sealing plunger.

Fig. 16 is a side view with a partial cutaway showing magnets in the top sleeve, and having a ball as the sealing plunger, the ball being made of a ferrous material such as stainless steel.

Before explaining the disclosed embodiment of the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the particular arrangement shown, since the invention is capable of other embodiments. Also, the terminology used herein is for the purpose of description and not of limitation.

invention is not limited in its application to the details of the particular arrangement shown, since the invention is capable of other embodiments. Also, the terminology used herein is for the purpose of description and not of limitation.

Detailed Description of the Invention

The present invention provides a plunger lift apparatus that consists of two basic parts, a PTM and a PBM that are latched together to form the UPM during lift. The plunger lift of the present invention basically consists of the following discrete steps:

1. The two piece plunger, or UPM, is at the bottom of a well in a mechanically latched state (magnetic or mechanical) with liquid loading on top of the plunger;
2. The well is open for flow at which time the UPM rises to carry liquids out of the well bore.
3. The UPM separates at the top of the well into its basic components, the PTM and PBM, via a de-latching rod (or other means) while the PTM

is secured in an auto-catcher and the PBM starts down the well at an increased speed against the well flow without effecting well operating efficiency due to its cross-sectional geometry, which will be described below in more detail.

4. The well flows for a set time or condition controlled by the well-head controller.

5. The auto-catcher releases the PTM after a set time or condition.

6. The PTM, with its hollowed center orifice, falls against the well flow at a faster rate than a standard plunger and latches to the PBM at the well bottom. The orifice allows the PTM to travel to the well bottom without impeding well flow and also optimizes plunger travel time in high liquid wells.

7. The well plunger lift cycle starts again.

The PTM and PBM that are latched together to form a single UPM during lift and separate back into two discrete parts (PTM and PBM) once at the well surface. The UPM acts as a sealed device during lift that functions to carry fluids to the well surface. The latching of the PTM and PBM

during lift is maintained via either magnetic or mechanical latching. The preferred embodiment of the present invention employs a magnetic latching design. It should be noted that mechanical latching could also be employed.

The utilization of magnetic (or mechanical) latching assures connection of the PTM and PBM during the UPM lift from the well bottom. The mechanical separation of the UPM into the PBM and PTM is accomplished by a rod or de-latching device at the top of the well, usually contained within the lubricator. Older systems employing a ball and top plunger mechanism tend to separate during lift causing lift restarts.

The PBM is geometrically designed to have a fluid/gas dynamic type shape to allow it to quickly pass against the flow and to the well bottom. Such designs may include, but not be limited to, a torpedo shape, an anvil shape, etc. The PBM is designed with outside dimensions to be sufficiently smaller than the tubing inside diameter allowing it to efficiently fall against the flow of the well. The PBM design allows gas or liquids to continue to flow to the well surface after the lift is complete and the PBM is falling against the well flow. The PBM will return to the bottom with an efficient speed until it comes to rest on the bottom

sitting or on a bumper spring. This aforementioned falling action of the PBM will allow the well to continue to flow and will not impact the well flow efficiency thereby allowing for higher well production levels. If the 'difference' in cross-sectional area of the PBM and the inside cross-sectional area of well tubing is equal to or greater than the minimum cross-sectional area of any other flow point in the well, full well flow can continue without the PBM impeding maximum flow. Likewise, no well flow will be impeded by the PTM if the inner orifice cross-sectional area of the PTM is greater than or equal to the minimum cross-sectional area of any other flow point in the well. The time to fall of both the PBM and the PTM is shorter than prior art allowing a time-savings in lift cycles, thus adding to well efficiency. Older design, solid plungers, not only required well shut-off, but also could not be released to fall back to the well bottom until flow had stopped.

In the preferred embodiment of the present invention, the PBM contains a relatively strong internal magnet. The magnet is positioned in proximity below the top surface of the PBM with its North and South poles facing in an axial direction along the PBM. A non-magnetic material is placed around the peripheral surface of the magnet (between the

magnet and the outside surface of the PBM) to optimize magnetic flux lines to flow between the magnet's north and south poles. The top surface of the PBM is designed with a magnetic material and is annular in shape with a slanted surface (cone type shaped) to optimize magnetic latching to similar but outside annular type surface on the PTM. It should be noted that other surface shapes could be employed. Although the PBM of the preferred embodiment might consist of separate parts; combinations of set pins, screw-type designs or other mechanisms can be used to secure all individual parts into a one-piece PBM to hold each of its components together.

When the UPM is lifted to the top of the well and separation occurs allowing the PBM to fall to the bottom, the PTM is caught and held at the top of the well by an auto catcher. The PTM is dropped back into the well when pre-determined well conditions are met. The PTM will re-latch to the PBM when it returns to the well bottom to form a united two-piece plunger, the UPM. The PTM is designed with an inside hollow orifice which allows it to quickly fall back into the well, against the well flow, without impacting well production. The outside surface of the PTM can be designed with any of the aforementioned type geometries such as ring,

pad, brush, solid or snake. The inside hollow orifice design permits an inherent flow by-pass when falling, thus eliminating any need for a separate by-pass valve. Elimination of by-pass valves as found in prior art plungers increases plunger reliability and also avoids extra maintenance associated with cleaning obstructed valve and/or passages. The bottom of the PTM is made of a ferromagnetic material to help produce the most strongly magnetic attraction in latching to the PBM. The shape of the bottom of the PTM is annular and with an inside conical opening at the orifice to accept the shape of the outside conical dimension of the PBM. When the PTM falls to the well bottom, it magnetically latches to the PBM. This magnetic latching assures continuous latching during lift. The shape of the top of the PTM can be designed such that it allows easy retrieval from the well bottom. An indented inside top collar would easily allow a ball and spring mechanism on a plunger retriever to fall inside the PTM orifice (under spring pressure) at its top position. The top collar of the PTM can be designed with a standard American Petroleum Institute (API) internal fishing neck. The spring loaded ball within the retriever and protruding outside its surface would thus fall within the API internal fishing neck at the

top of the PTM orifice for a small distance to a point wherein the inside diameter of the PTM orifice would increase to allow the ball to spring outward. This condition would allow retrieving of the entire UPM as the UPM is in its latched state.

Alternate embodiments of the present invention can utilize a mechanical latching of the PTM and PBM during lift. Such embodiments might employ mechanical means such as ball and spring mechanisms on one device (PTM or PBM) to latch into a grove on the other device (PBM or PTM).

The present invention assures an efficient lift due to the fact that both the PTM and PBM are latched to form one plunger unit during lift. The present invention also optimizes well efficiency due to the fact that both PTM and PBM can separately and quickly travel to the well bottom. Preliminary data indicates productivity increases ranging from 120% to 200% depending on well parameters.

Referring now to the drawings, Fig. 2 is a side view of the preferred embodiment of UPM **200** separated into both the PTM **20** and PBM **21**. PTM **20** is shown with a 'solid ring' **22** sidewall geometry. As previously described, other sidewall geometries such as 'brush', 'ring', 'pad' etc. can be employed in PTM **20**. PTM **20** is basically an annular apparatus

with an inner orifice, which can be seen below in Figs. 3, 4A. PBM **21** is shown with an anvil-type shape to optimize efficiency when dropping against the well flow, while allowing the well flow to continue. PBM **21** consists of the following components:

1. Liquid/gas by-pass bottom end **24** with a mandrel type section with main flute **23** in a triangular shape and outer flutes **17** as inverted triangular shaped areas (see Fig. 2A);
2. By-pass south connector **25**;
3. Magnet isolator ring **26**, which is made of non-magnetic (anti-ferromagnetic) material, and contains the magnet (not shown). Magnet isolator ring **26** can be seen externally as an annular ring around the area surrounding the internal PBM magnet; and
4. By-pass head **28**.

Fig. 2A is a cross-sectional view of the PBM **21** unit across point A-A of Fig. 2. The A-A cross-sectional area of the liquid/gas by-pass end **21** is shown as a mandrel type section with main flute **23** in a triangular shape and outer flutes **17** as inverted triangular shaped areas. It should be

noted that although a specific geometry is shown, other geometries can be easily designed (for example, anvil shaped, spear shaped or other) that would allow PBM **21** to easily fall against the well flow. A good design for PBM **21** can be obtained if the cross-sectional area for 'any' cross section cut across PBM **21** has an area such that the 'difference' between the cross-sectional area of PBM **21** and the cross-sectional area of the inner diameter of tubing **8** (ref. Fig. 1) is greater than the 'minimum' cross-sectional area of any other flow point in the well. This will assure that PBM **21** does not impede the well flow. Likewise, the cross-sectional area of PTM orifice should be equal to or greater than the 'minimum' cross-sectional area of any other flow point in the well.

Fig. 3 is a side cross sectional view of the preferred embodiment of a UPM **200**, shown in its magnetically latched state with PTM **20** magnetically latched to PBM **21**. PBM **21** is magnetically drawn into the bottom orifice of PTM **20** when fully magnetically latched. PBM **21** is shown in the preferred embodiment consisting of a plurality of sub-assembly components. Liquid/gas flow by-pass end **24** is designed in mandrel-type geometry to assist PTM **20** to easily fall

against the well flow. Other geometries (i.e., anvil, spear, torpedo etc.) could also be employed. Other PBM **21** subassembly parts consist of subassembly bypass south connector **25**, magnet isolator ring **26** (anti-ferromagnetic material), magnet **27**, and by-pass head **28.** Surface **S** is the conical surface at which annular surfaces from PTM **20** and PBM **21** are held magnetically and acts as a seal during lift. Annular upper surface **S3** provides a secondary seal. Magnet **27** is of sufficient strength to pull PBM **21** up into the receiving PTM orifice **29**. Magnetic flux lines **M** are shown which permeate both sections of PTM **20** and PBM **21**. PTM **20** is shown with a solid ring **22** outer surface geometry. Inner cut groves **30** of this geometry allow sidewall debris to accumulate when PTM is rising or falling. Other outer surfaces can also be employed (ref. Fig. 6). The top of PTM **20** is designed as an API internal fishing neck for easy retrieval by a standard API internal fishing neck retrieving pickup mechanism (not shown) to retrieve UPM **200** in its mechanically latched form.

Figs. 4A, 4B is a blow up view of UPM **200** showing each subassembly of PBM **21**. PTM **20** is shown with a solid ring **22** outer surface geometry and containing inner groves **30**.

Liquid/gas by-pass end **24** is fluid/gas dynamic in shape allowing it to cut through the well flow. Shapes other than that shown can also be employed. Bottom end threaded area **41** allows for mechanical threading connection to bypass south connector **25** lower threads **43**. Liquid/gas by-pass roll pin hole **40** and bypass south connector roll pin hole **42** are aligned for a pressed pin (not shown) positive retention mechanism between liquid/gas by-pass end **24** and bypass south connector **25**. ~~It~~A ~~M~~magnet insulator ring **26** is attached to bypass south connector **25** via screwing south connector treads **44** and magnet insulator ring treads **46**. The magnet insulator ring 26, which is a non-magnetic element such as aluminum, serves to isolate the sides of the magnet, thereby radiating longitudinally the magnetic flux lines M (see Fig. 3) to better couple the magnet 27 to the PTM 20. Bypass south connector roll pin hole **45** and magnet insulator ring roll pin hole **47** are aligned for a pressed roll pin (not shown) positive retention to hold both sub-assemblies into position. Magnet **27** is permanently positioned and is shown such that its north pole **N** faces upward and its south pole **S** faces downward. It should be noted that magnet **27** could also be aligned in an opposite manner to that shown, that is,

with its north pole **N** facing downward and its south pole **S** facing upward. Surface **S1** is aligned and extends to surface **S2** when both subassemblies are together. These form annular surface **S** (ref. Fig. 3) of PBM **21** at which point PTM **20** and PBM **21** are held together magnetically. By-pass head **28** mates to magnet insulator ring **26** via by-pass head treads **49** and magnet insulator treads **48**. Both units are mechanically held together by a roll pin (not shown) placed by aligning magnet insulator roll pin hole **47** with by-pass head roll pin hole **50**. Roll pins are inserted after alignment and retained via compression or spreading of roll pin end(s). It should be noted that alignment of all roll pin holes in PBM **21** could be accomplished by any of the following methods:

1. Threading all PBM parts together and then drilling a roll pin holes in appropriate locations.
2. Pre-drilling roll pin holes and aligning holes after PBM parts are threaded together.

It should also be noted that other means of connecting PBM parts can be accomplished via use of adhesives within the threads to hold parts together (i.e. no roll pins) or other fastening means.

Fig. 5 is a side view of PTM **20** with solid rings **22** sidewall geometry for durability and containing inner groves **30**. Sidewall geometry can be made of various materials such as steel, poly materials, Teflon, stainless steel, etc. Cross-section B-B is described below in Fig. 12.

Fig. 6 is a side view of various side-wall geometries of the PTM. All geometries described below have an internal orifice as previously described in PTM **20**. All side-wall geometries described below can be found in present industrial offerings. These side-wall geometries are described as follows:

A. As previously discussed solid ring **22** sidewall is shown in solid plunger PTM **20**. Solid sidewall rings **22** can be made of various materials such as steel, poly materials, Teflon, stainless steel, etc.

B. Shifting ring **81** sidewall geometry is shown in shifting ring plunger top mechanism **80**. Shifting rings **81** sidewall geometry allows for continuous contact against the tubing to produce an effective seal with wiping action to ensure that all scale, salt or paraffin is

removed from the tubing wall. Shifting rings **81** are all individually separated at each upper surface and lower surface by air gap **82**.

C. Pad plunger top mechanism **60** has spring-loaded interlocking pads **61** in one or more sections. Interlocking pads **61** expand and contract to compensate for any irregularities in the tubing thus creating a tight friction seal.

D. Brush plunger top mechanism **70** incorporates a spiral-wound, flexible nylon brush **71** surface to create a seal and allow the plunger to travel despite the presence of sand, coal fines, tubing irregularities, etc.

Fig. 7 is a side view of the UPM **200** with magnetic latching, the preferred embodiment of the present invention. Shown are aforementioned PTM **20** and PBM **21**. It is shown again for reference purposes alongside alternate embodiments.

Fig. 8 is a side view of latch-down pickup **300**, an alternate embodiment of the present invention. In this alternate embodiment, latch down top mechanism **310** is mechanically latched to latch down bottom mechanism **302**.

Fig. 8A is a blow up of the latch-down pickup area **303**. At the bottom of latch down top mechanism **310** is a set of two or more female pickup fingers **304**, which wrap around recessed male sleeve **305**. Recessed male sleeve **305** is tapered down from upper neck **306** providing a recess for female pickup fingers **304** to compress around recessed male sleeve **305**. Female pickup fingers **304** (two or more) will expand in direction **307** as shown when upper neck **306** enters latch down top mechanism **310** and contract when over tapered down recessed male sleeve **305**. Surface mating area **S3** provide for a seal upon plunger lift. An orifice in latch down top mechanism **310** is similar to PTM orifice **29** as previously described. As aforementioned extracting rod **4** (ref. Fig. 1) separates latch down top mechanism **310** from latch down bottom mechanism **302** upon lift completion at the well top.

Fig. 9 is a side view of a compression ring pickup **400**. In this alternate embodiment, compression ring top mechanism **410** is mechanically latched to compression ring bottom mechanism **402**. Fig. 9A is a blow up of the compression ring pickup area **403**. At the bottom of compression ring top mechanism **410** is recessed groove annular ring **404**, which allows compression ring **405** to expand, thereby allowing compression ring top mechanism **410** to mechanically latch to compression ring bottom mechanism **402**. Compression ring **405**

is affixed to compression ring bottom mechanism **402** and will compress as compression ring bottom mechanism **402** enters compression ring top mechanism **410**. Compression ring **405** can be made with various compressible materials such as, but not limited to, rubber, nylon, steel, or other metallic or poly-type materials. Surface mating area **S3** provides for a seal upon plunger lift. An orifice in compression ring top mechanism **410** is similar to PTM orifice **29** as previously described. As aforementioned extracting rod **4** (ref. Fig. 1) separates compression ring top mechanism **410** from compression ring bottom mechanism **402** upon lift completion at the well top.

Fig. 10 is a side view of a spring-loaded pickup **500**, still another alternate embodiment of the present invention. In this alternate embodiment, spring-loaded top mechanism **510** is mechanically latched to spring-loaded bottom mechanism **502**. Fig. 10A is a blow up of the spring-loaded pickup area **503** as shown in Fig. 10. At the bottom of spring-loaded top mechanism **510** is recessed area containing spring **504** and ball **505**, which sit in slot hole **507**. Ball **505** will contract into spring **504** when spring-loaded bottom mechanism **502** enters spring-loaded top mechanism **510**. Spring-loaded bottom mechanism **502** contains recessed annular grove (bearing race) **506** which will allow ball **505** to expand out from spring **504** and maintain a mechanical connection

between units a spring-loaded bottom mechanism **502** enters into spring-loaded top mechanism **501.** Surface mating area **S3** provides for a seal upon plunger lift. An orifice in spring-loaded top mechanism **501** is similar to PTM orifice **29** as previously described. As aforementioned extracting rod **4** (ref. Fig. 1) separates spring-loaded top mechanism **501** from spring-loaded bottom mechanism **502** upon lift completion at the well top.

It should be noted that other type of mechanical pickup mechanisms could be designed to insure a 'positive' mechanical contact during plunger lift.

Fig. 11 is a horizontal cross-sectional view of Fig. 2, taken along line A-A, viewed in the direction taken by the arrows. Shown is PBM **21** inside of inner diameter **ID** of well tubing **9**. If area **A2** is equal to or greater than the minimum cross-sectional area of any other flow point in the well, full well flow can continue without the PBM impeding maximum flow. PBM **21** has many different cross-sectional areas, and although only one area is shown, if the 'difference' in any cross-sectional area of the PBM and the inside cross-sectional area of well tubing is equal to or greater than the minimum cross-sectional area of any other flow point in the well, full well flow can continue without the PBM impeding maximum flow.

Fig. 12 is a horizontal cross-sectional view of Fig. 5, taken along line B-B, viewed in the direction taken by the arrows. PTM **20** is shown inside inner diameter ID of tubing **9**. A very small gap **G** between the outside of PTM **20** and inside diameter **ID** of tubing **9** allows PTM **20** to travel down tubing **9** to the well bottom where it will attach to PBM **21**. In this case the inside cross-sectional area **A1** of orifice **29** should be equal to or greater than the 'minimum' cross-sectional area of any other flow point in the well in order to optimize well flow.

Referring next to FIG. 13 the spring-loaded topmechanism 510 is shown and described in FIG. 10. However, a ball B serves as the sealing plunger, also called the bottom mechanism.

Referring next to FIG. 14 the compression ring top mechanism 1410 has an O ring, also called a compression ring 1411 in a groove 1411 of the lower arm 1412. This embodiment functions similar to the FIG. 9 embodiment using a ball B as the bottom mechanism.

Referring next to FIG. 15 the latch down top mechanism 310 is shown and described in FIG. 8. However, a ball B serves as the bottom mechanism.

Referring next to FIG. 16 the top mechanism, also called the sleeve 1600 has its lower segment 1601 shown in a cutaway view to display magnets M which attract ball B. Ball B serves as the bottom mechanism as in FIGS. 13, 14, 15.

Although the present invention has been described with reference to preferred embodiments, numerous modifications and variations can be made and still the result will come within the scope of the invention. No limitation with respect to the specific embodiments disclosed herein is intended or should be inferred.